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$$A=\pi ab=\pi\times\frac{2h}{c_1h+\sqrt{(c_1^2h_2-4k)}}\times\frac{2h}{c_1h-\sqrt{(c_1^2h_2-4k)}}=\frac{\pi h}{\sqrt{k}}.$$

For the area of any curve, we have from the calculus

$$A=\tfrac{1}{2}\int_{\theta_0}^{\theta_1}r^2d\theta.$$

If we regard the angle θ_0 as the initial angle it is 0, and as θ is a function of the time, this integral may be written

$$A=\tfrac{1}{2}\int_0^{t_1}r^2d\theta=\tfrac{1}{2}\int_0^{t}r^2\frac{d\theta}{dt}dt=\tfrac{1}{2}h\int_0^{t_1}dt=\tfrac{1}{2}ht \text{ by } (3).$$

$\therefore$ $t=2A/h$. That is, the periodic time always equals twice the area swept over by the radius vector divided by the constant h.

Hence for the given ellipse we have

$$t=\frac{2\pi h/\sqrt{k}}{h}=\frac{2\pi}{\sqrt{k}}.$$

Therefore the time it would require for a piece to travel from the point of explosion to the next point of intersection is $\tfrac{1}{2}t-\pi/\sqrt{k}$, and as k is a constant the same for all pieces, we see this time is the same for all, and hence they must collide simultaneously.

91. Proposed by **CHARLES C. CROSS**, Whaleyville, Va.

The bow of a boat which is a inches wide is inclined at an angle α. When in motion in perfectly calm water the water was found to rise b inches on the bow. Required the velocity of the boat.

No solution of this problem has been received.

92. Proposed by **WALTER H. DRANE**, Graduate Student, Harvard University, Cambridge, Mass.

A particle, starting at the vertex, slides down a smooth parabolic curve. Find the initial velocity of the particle so that it may leave the curve at the extremity of semi-latus rectum.

Solution by **GEORGE R. DEAN**, A. M., Professor of Mathematics, University of Missouri School of Mines and Metallurgy, Rolla, Mo.

Take the vertex as origin and positive x downwards.

The equation of the curve is $y^2=2px$.

Let N be the normal reaction, v the velocity, θ the angle between normal and x-axis, m the mass of particle, ρ the radius of curvature.

Then $N=mv^2/\rho+mg\cos\theta$.

$$\rho=\frac{(y^2+p^2)^{\frac{3}{2}}}{p^2},\quad v^2=v_0^2+2gx,\quad \cos\theta=\frac{p}{\sqrt{(y^2+p^2)}}.$$

Accordingly, $N=mg(p-\frac{v_0^2}{g})=\frac{m}{p}(pg-v^2)$.

If $v_0^2=pg$ the normal reaction is always zero.
If $v_0^2>pg$ the particle leaves the curve at once.
If $v_0^2<pg$ the particle is constrained to move on the curve.
Then the particle either—
1°. Describes the curve freely without leaving it ; or,
2°. Leaves the curve at the beginning of the motion ; or,
3°. Describes the curve under constraint without leaving it.

Also solved by *G. B. M. ZERR*, and the *PROPOSER*.

DIOPHANTINE ANALYSIS.

75. **Proposed by CHARLES CARROLL CROSS. Whaleyville, Va.**

Arrange the consecutive integers 1 to n^2 as a magic square, where n is odd. Apply when $n=9$.

Solution by M. A. GRUBER, A. M., War Department, Washington, D. C.

This solution for odd magic squares is adapted from a similar solution found in an article on "Evening Entertainments."

We divide a large square into as many little spaces as there are numbers in the magic square.

We conceive a similar large square, similarly divided, bordering on the right, another on the bottom, another on the left, and a fourth meeting the right bottom corner of the given square.

We fill in the numbers consecutively, commencing with unity, *from left diagonally down to right, beginning with the space immediately below the center space.*

When reaching the limit of the given square, we continue the next number into the "bordering square." This number will then be placed in the *corresponding space of the given square.*

When, in filling in the numbers, we meet a space that is already occupied, we take the space *next diagonally down left from this occupied space*, and continue as before.

Take a magic square having 9 numbers on a side. There will then be 9^2, or 81 spaces in the square, to be filled with the numbers 1 to 81 inclusive.

Beginning with the space next below the center space, and filling in diagonally down to right, we find 4 reaches the limit of the square. Whence 5 occupies, in the "bordering square," the right upper corner. We now put 5 in the right upper corner of the given square, and find it at the limit of the square. Whence 6 occupies, in the "bordering square," the space next below the left upper corner. We now place 6 in the corresponding space of the given square, and proceed 6, 7, 8, 9, when we meet the space occupied by 1. We then put 10 in the space next diagonally down left from 1, and proceed 10, 11, 12, etc., until all the spaces are filled.